

# Sustainability of Cold-climate Strawberry Production Systems

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## Abstract

An experiment was conducted to compare three cold-climate strawberry production systems. Replicated field plots of conventional matted row, advanced matted row and cold-climate plasticulture production systems were established in 2002 at Beltsville, MD, and managed according to commercial standard practices for the region. The following components of sustainability were determined: economic viability and efficiency, environmental impacts, and public acceptance. Marketable yields for the first harvest season in the spring of 2003 were lower than normal due to above average rainfall and high disease incidence. The conventional matted row was the highest yielding at 17,400 kg/ha, followed by the advanced matted row and plasticulture with 13,200 and 11,800 kg/ha, respectively. During the establishment year, soil loss from rain-induced surface runoff was more than 4-fold greater in conventional matted row, and 1.5-fold greater in plasticulture compared to advanced matted row. To identify preferences of pick-your-own customers, volunteers harvested fruit from subplots in each system and completed questionnaires. Overall, the volunteers indicated a preference for plasticulture, which was likely a result of larger fruit size, ease of harvest, and a higher percentage of marketable fruit.

## INTRODUCTION

Growers and researchers in the mid-Atlantic region of the United States have long recognized inefficiencies in the conventional matted row production system common to the area, and have searched for viable alternative production systems (Hancock et al., 1997; Black et al., 2002). Problems with the conventional matted row system include high water use and inefficient irrigation coverage, high labor costs for weed control, and soil erosion. Some growers have experimented with a cold-climate plasticulture system that offers the benefits of better weed control, more efficient irrigation, and larger and earlier-ripening fruit (O'Dell and Williams, 2000). However, this system has higher startup costs (Larson, 1996) that in colder climates provide increased financial risks for often marginal increases in returns.

Many growers in the mid-Atlantic region have small farms, and grow multiple crops that are marketed on site, often to pick-your-own (PYO) customers. A sustainable production system for this region would be economically profitable, with little negative environmental impact, and acceptable to the population of PYO customers.

## MATERIALS AND METHODS

Three strawberry production systems, conventional matted row, advanced matted row, and cold-climate plasticulture, were established in three replicate plots measuring 6 x 15 m each, in order to compare sustainability. Conventional matted row is the regional standard production system in the mid-Atlantic United States, and consists of flat beds with overhead irrigation, cultivation, and broadcast fertilizer application. Advanced matted row and cold-climate plasticulture systems were managed as previously described by Black et al., 2002. 'Allstar' was used for all systems due to its exceptional performance in



each of the systems at this location (Galletta et al., 1981; Black et al., 2002). Cold stored dormant plants were used for the conventional matted row and advanced matted row treatments and plugs were used for the plasticulture system.

To determine economic viability, a profitability analysis was performed which included all starting materials, chemical, mechanical, and labor inputs, and total marketable fruit yield. Environmental impacts during the establishment year and first fruiting season were measured by collecting surface runoff samples with automated runoff samplers installed in each plot and collecting soil leachate samples from suction lysimeters. Runoff samples were analyzed to determine soil, nutrient, and pesticide loss, and lysimeter samples were analyzed for nutrient and pesticide leaching. Volunteers were recruited to evaluate consumer preference. Each volunteer harvested a small subplot from each system and completed a survey to provide opinions of each system. We are presenting selected results from establishment to first harvest.

## **RESULTS**

### **Economics/Efficiency**

Spring of 2003 was very wet due to above average rainfall, and yields were decreased across systems due to high incidence of fruit rot. However, a fungicide spray regimen did allow us to produce a moderate crop in each system and provided a reasonable yield comparison. The conventional matted row had the highest total marketable yield of the three systems, at 17,400 kg/ha, compared to 11,800 and 13,200 for plasticulture and advanced matted row, respectively (Table 1). Crown development in the plasticulture system was less than expected, perhaps due to a later than optimal planting date, which combined with the amount of culled fruit (Table 1) resulted in low yield. However, fruit size was significantly higher in plasticulture compared to the other systems and percentage of unmarketable fruit significantly lower in plasticulture compared to conventional matted row.

### **Environmental Impacts**

During the establishment season (2002), the region experienced drought conditions with few rain events. Above average rainfall during the first fruiting year (2003) resulted in 28 sampled rain events prior to the first harvest. Soil loss from rain-induced surface runoff during the establishment year was 650 kg/ha for conventional matted row, compared to 220, and 150 kg/ha for plasticulture and advanced matted row, respectively (Fig. 1). The increased soil loss in conventional matted row likely resulted from several intense rainfall events that occurred shortly after cultivation for weed control. After straw was added in winter 2002, soil erosion was dramatically reduced in all systems.

### **Public Acceptance**

The purpose of the survey was to evaluate consumer preferences among systems, and determine whether preferences were based on such factors as quality of fruit, ease of harvest, or appearance. Representative results are shown in Table 2. Consumers showed a preference toward the plasticulture, particularly early in the season when the earlier fruiting plasticulture system was more productive. Later in the season there was no clear preference among consumers for one system over another.

## **DISCUSSION**

The plasticulture system was favored by consumers largely due to more marketable and larger fruit, and ease of harvest. However, respondents did not specify a willingness to pay more for fruit from the plasticulture system. This indicates that although most consumers would prefer to pick from plasticulture, they did not value it more and would be just as likely to frequent PYO farms that used another system. The advanced matted row was preferred over the conventional matted row, and had yields comparable to the plasticulture but had smaller fruit than the plasticulture.

The advanced matted row system had a clear advantage over the other two production systems in reducing soil loss. The conventional matted row system lost more than 4-fold more soil than the advanced matted row, and the plasticulture lost 1.5 times more soil, despite being planted 3 months later. After the systems were established and straw was added, soil loss in plasticulture was lower than expected compared to plasticulture systems for other crops (Rice et al., 2001).

Through the first harvest season, both the plasticulture and advanced matted row systems offer advantages over the conventional matted row. Despite being the highest yielding system, the conventional matted row had the most pronounced negative environmental impacts, and pick-your-own customers generally disliked picking from it. A second harvest year in 2004 will help to further explain the differences among these systems, and provide additional data for a quantitative comparison of relative sustainability.

## ACKNOWLEDGMENTS

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## Tables

Table 1. Comparison of harvest data for 2003 between conventional matted row, advanced matted row, and cold-climate plasticulture.

Treatment	Marketable Yield (kg/ha)	Mean Fruit Size (g)	Unmarketable Fruit (%)
Conventional matted row	17,400a <sup>z</sup>	18.3a	33.1a
Advanced matted row	13,200b	16.8a	32.0ab
Plasticulture	11,800b	22.9b	21.4b

<sup>z</sup> Means followed by different letters are significantly different at the 5% level



Table 2. Percentage of surveyed volunteers indicating a preference for a particular system out of total number of 15 completed responses per harvest.

Treatment	2-jun	5-jun	10-jun	13-jun	16-jun	Mean
Conventional matted row	0.0	6.7	18.8	36.8	35.7	20.5
Advanced matted row	18.8	40.0	25.0	31.6	28.7	28.2
Plasticulture	81.2	53.3	56.3	31.6	35.7	51.3

## Figures

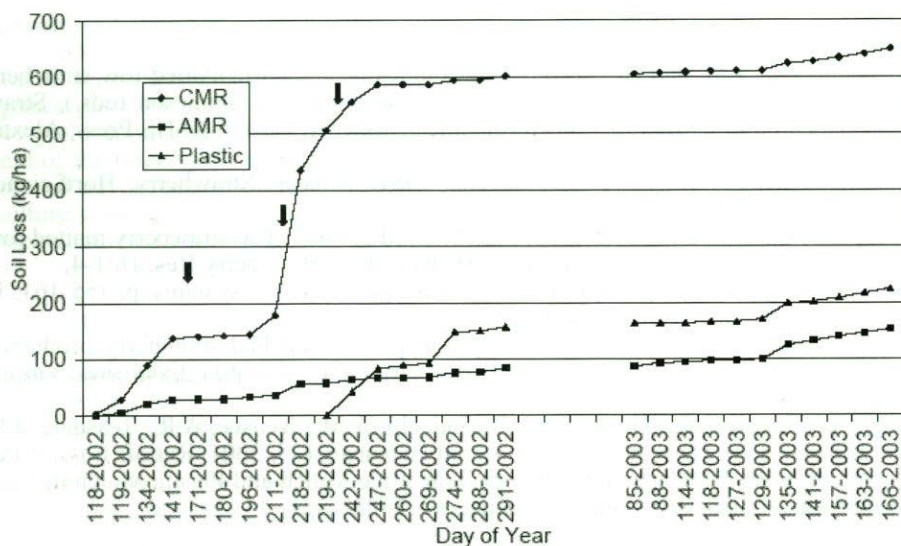


Fig. 1. Soil loss during establishment year. Break in graph represents winter months when sampling was not performed. Straw covered the plants at this time and was moved to between the rows in March 2003. Arrows represent cultivation dates.